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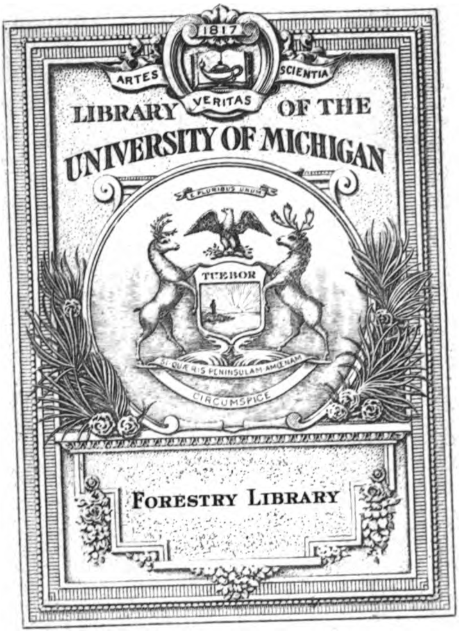

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BUREAU OF PLANT INDUSTRY—Circular No. 127.

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MISCELLANEOUS PAPERS.

The Work of the Delta Experiment Farm in 1912	JOHN P. IRISH, JR.
Silver Scurf, a Disease of the Potato	I. E. MELHUS
The Dasheen, a Root Crop for the Southern States	ROBERT A. YOUNG

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THE WORK OF THE DELTA EXPERIMENT FARM IN 1912.[1]

By John P. Irish, Jr., *Farm Superintendent, Office of Western Irrigation Agriculture.*

INTRODUCTION.

DESCRIPTION OF THE REGION.

The Delta Experiment Farm is located on the Lower Jones Tract, one of the islands in the south-central portion of the San Joaquin Delta. The tract is typical of the general San Joaquin Delta lands. The soil is a very light peat, characteristic of most of the reclaimed land on the San Joaquin side of the delta.

These lands lie at sea level and before their reclamation were flooded during the major portion of the year. The delta of the combined Sacramento and San Joaquin rivers occupies an aggregate area of about 250,000 acres.

Reclamation is accomplished by leveeing to exclude tidal and flood waters and by the installation of ditches and pumps discharging into the river to furnish drainage and control the ground-water level. The drainage system consists of main drainage ditches or canals from 18 to 30 feet wide and from 7 to 12 feet deep, into which empties a secondary system of hand-dug ditches 3 to 4 feet wide and 4 to 6 feet deep. These secondary ditches divide the land into blocks or fields of from 10 to 100 acres, the average unit being 50 acres.

Since the rainfall of the section averages only about 15 inches per year, irrigation is necessary for the production of crops. The secondary ditch system is used both for drainage and as head ditching for irrigation, the water being drawn into it from the river channels by means of siphons over or headgates through the levees.

The climate is mild, and plant growth is continuous throughout practically the entire year. This somewhat complicates the problem of controlling weeds and plant diseases, the latter being specially difficult to eradicate because of the continuous growth of many of the host plants.

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[1] Issued May 17, 1913.

The Delta Experiment Farm was established in 1911 at Middle River, 14 miles west of Stockton, Cal., on a tract of land comprising about 100 acres provided by the Delta Association of California. This association is composed of farmers who are operating in the delta region, and the organization cooperated with the Bureau of Plant Industry in the work here reported. The University of California is also conducting investigations on the same tract, about 50 acres being used for this purpose. Actual operations were begun in the spring of 1912. The work in which the Bureau of Plant Industry was directly concerned in 1912 was devoted to experiments with potatoes. This work was under the immediate supervision of Mr. John P. Irish, jr., who was detailed from the Bureau of Plant Industry.

CROPPING SYSTEMS.

The principal crops grown are potatoes, barley, beans, and onions. A large acreage is also devoted to asparagus, and celery is grown to some extent. The principal cash crop of the region is potatoes, 52,000 acres being devoted to this crop in the delta region in 1912. The barley acreage, while large, usually gives a much lower acreage return than potatoes.

The present cropping system on the San Joaquin side of the delta is based principally on a 2-year rotation of potatoes and barley. In many cases tenants holding term leases grow barley hay, beans, and onions instead of barley in alternation with potatoes, but in a majority of cases the barley-potato rotation is the accepted one, the effort usually being to devote as much land to potatoes as possible, although the exigencies of the potato market and the decrease in potato yields sometimes cause individual owners to hold their lands in barley for more than one season in an effort to improve conditions. The lands are farmed largely on an annual tenancy system, the potato tenant moving from farm to farm with the rotation of the crops, while the barley tenant farms each year an aggregate area comprising five or more potato farms. The unit area of potato farming is from 100 to 300 acres.

Potatoes are planted from the latter part of March till early June, the bulk of the planting being done in April and May. The harvest ordinarily extends from the last of September to the first of January, the potatoes being dug as the market requires them.

The land is given a preliminary plowing in the early spring to check the weeds and improve the soil tilth and is then allowed to lie from one to three months. Planting is done while plowing, the seed being dropped by hand in the alternate furrows. The seed piece is commonly cut to two eyes. The spacing is from 30 to 32 inches between the rows and 8 to 12 inches between hills, giving about 20,500 plants to the acre as a maximum stand. The ground is harrowed from one to three times before the plants are large enough to be damaged. When the plants are large enough to define the rows, ditches 10 inches wide with an average depth of 18 inches are cut between two rows 60 to 70 feet apart. Water is later run into these ditches from the head ditches, regulated to fill them nearly full, and irrigation is accomplished by lateral percolation. Three to five irrigations are given during the growing season, the number depending on the soil and climatic conditions and the height of the ground-water table. The crop is given one or two hand hoeings, one to three cultivations, and one hilling. Harvesting is done by hand with potato hooks, the sorting being done during the digging, the culls usually being left in the field. This method, while tedious, expensive, and rather wasteful, is made necessary by the physical peculiarities of the peat soil, in which no machine digger so far tried has done effective work.

PREVIOUS INVESTIGATIONS.

Progressive decrease in potato yields and a lowering of quality under the present methods of cropping led to an investigation of the potato situation in 1908 by the Office of Cotton and Truck Disease and Sugar-Plant Investigations of the Bureau of Plant Industry, and the results were published in 1909.[1] These results seemed to indicate that the decrease in yield and quality was due largely to pathological conditions. Some preventive measures were described, but it was stated that further investigation was necessary, particularly in connection with the improvement of cropping systems and cultural methods.

EXPERIMENTS WITH POTATOES IN 1912.

In the spring of 1912 work was begun by the Office of Western Irrigation Agriculture looking to the improvement of cropping methods on these lands. Since potatoes are the crop upon which the landholders depend for maximum returns, their place and duration in any rotation are of great importance. In the work for the crop season of 1912 the main aim was to determine what method of tillage, fertilization, and rotation may be expected to give the best results in potato production and weed control.

It was thought that the potato wilt might be controlled by increasing the vigor of the plants and that the damage from scab might be reduced by acidulating the soil. For this reason the experiments included methods of stimulating plant growth, particularly through the use of commercial fertilizers, and also included methods of acidulation. The Burbank variety was used in all the trials.

The land used in 1912 comprised about 32 acres in three fields (fig. 1), as follows: Field F, 15.5, field G, 6.6, and field I, 10 acres. This land had been planted to potatoes in 1911 and was very weedy when taken over for experimental purposes.

In most of the experiments determinations were made of the stand, the extent of potato wilt (*Fusarium oxysporum*), the extent of scab, a disease due to a fungus (*Oospora scabies*), and the yield of marketable tubers and of tubers of unmarketable sizes. The method followed in these determinations and the meaning of the figures used in the following tables are described later.

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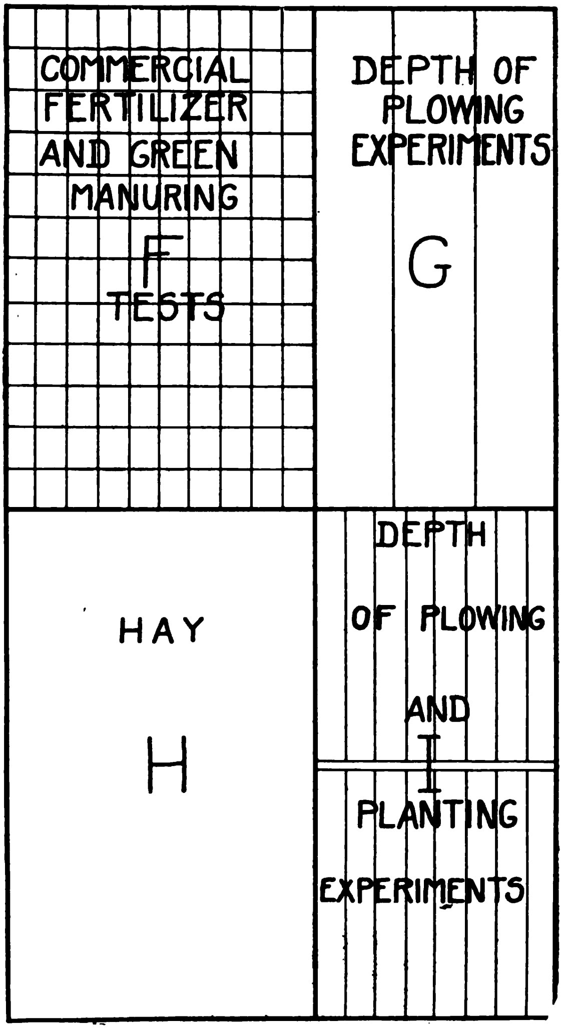
[1] Orton, W. A. Potato Diseases in San Joaquin County, Cal. U. S. Department of Agriculture, Bureau of Plant Industry, Circular 23, 14 p., 1909.

During the growing season a count was made of the actual stand on the plats, and during the latter part of September a count was made of the wilted plants. In tabulating the results of these counts the percentage of stand was determined by computing the percentage of a perfect stand, estimated by the distance between rows and hills on each plat; the potatoes having been planted at the usual distances as described above, a stand of 20,500 plants per acre was taken as 100 per cent. The percentage of wilt was computed as the ratio between the wilted plants and the actual stand.


COMMERCIAL FERTILIZER AND GREEN MANURING
F
TESTS
DEPTH OF PLOWING EXPERIMENTS
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PLANTING EXPERIMENTS

FIG. 1.—Diagram showing the fields used in the experiments with potatoes at the Delta Experiment Farm in 1912.

In October and November a sample digging was made of four rows equidistant across each plat. In this digging all the potatoes in each hill were gathered, regardless of size or condition, and a sorting was made in which all potatoes of marketable size and in marketable condition were segregated, weighed, and classed as marketable. The culls were then sorted and weighed, being classed as undersized or scabby. The undersized scabby potatoes were classed as undersized, and only the potatoes which but for the scab would have been marketable were classed as scabby. In computing the results of the sample digging, the percentage of scab and unmarketable sizes was determined in terms of the marketable potatoes obtained in this digging, and the results were taken as being representative of the plat as a whole.

In December and January the final digging of marketable potatoes was made, and this yield when added to the marketable potatoes obtained during the sample digging and computed to an acreage yield is carried in the tables as the market yield.

TESTS OF TILLAGE METHODS WITH GREEN MANURE AND COMMERCIAL FERTILIZERS.

Alternate lands in field F were plowed 6 inches and 12 inches deep, respectively, in February. The north half of the alternate pairs was sown to vetch early in March, and the south half of the same pair was sown to barley. Certain blocks of these lands were treated with commercial fertilizers. The vetch made very little growth, but the barley reached a height of 15 to 18 inches by the middle of May, when the lands were replowed.

In addition to the fertilizers applied in March on certain of the green-manured and bare plats, fertilizer was applied in the rows of potatoes on certain other of the green-manured and bare plats at planting time, early in June. The fertilizers used in both cases were K_2SO_4 (potassium sulphate), KCl (potassium chlorid), and $CaHP_2O_6$ (superphosphate). All were very high grade. All planting on field F was at a depth of 6 inches. The results of this test are given in Table I, together with comparisons of the results obtained with the same green manures and tillage methods but without the use of commercial fertilizers.

For convenience in comparing averages, the data are given in condensed form at the close of the table where the averages of all the results obtained with commercial fertilizers are compared with the results secured on the unfertilized plats.

TABLE I.—*Results obtained with potatoes under various tillage methods and with various commercial fertilizers at the Delta Experiment Farm in 1912.*

Fertilizer (applied at 140 pounds per acre).	Item.	Tillage methods with green and artificial manures.								Average of all tillage methods.		Tillage methods and green manure without commercial fertilizers.			
		Fertilizers applied in March.				Fertilizers applied when planting.									
		Deep plowed.		Shallow plowed.		Deep plowed.		Shallow plowed.				Deep plowed.		Shallow plowed.	
		Green manure.[1]	Bare.[2]	Green manure.[1]	Bare.[1]	Green manure.[1]	Bare.[1]	Green manure.[1]	Bare.[1]	With commercial fertilizer.	Without commercial fertilizer.	Green manure.[3]	Bare.[4]	Green manure.[3]	Bare.
Superphosphate	Stand.....per cent	37.0	31.8	34.1	28.9	28.8	25.2	27.0	29.1	30.1	31.3	29.5	31.0	34.7	30.0
Do	Wilt.....do	93.0	84.5	75.0	75.3	82.0	67.0	58.0	76.0	76.3	74.5	79.0	70.0	75.0	74.0
Do	Marketable yield,[5] pounds	9,330	8,503	7,235	7,330	10,825	4,581	4,827	6,752	7,422	6,607	7,939	6,445	5,772	6,272
	Unmarketable:														
Do	Undersized.....per cent	23.5	25.0	21.9	22.1	27.5	20.8	56.3	38.8	29.3	22.9	21.4	24.2	25.5	20.5
Do	Scabby.....do	8.2	13.9	2.2	5.3	7.6	10.0	2.9	1.3	6.4	5.5	5.1	6.4	4.7	5.7
Potassium chlorid	Stand.....do	38.0	30.2	32.1	31.3	20.0	15.9	25.4	25.1	27.4	31.3				
Do	Wilt.....do	83.0	76.0	82.0	57.3	55.0	53.0	55.0	17.5	59.8	74.5				
Do	Marketable yield,[5] pounds	9,505	7,253	6,245	6,528	7,531	3,764	4,875	3,697	6,208	6,607				
	Unmarketable:														
Do	Undersized.....per cent	17.6	18.1	15.4	17.0	28.0	27.2	27.7	36.4	23.4	22.9				
Do	Scabby.....do	2.7	3.9	4.2	5.0	13.1	5.0	2.9	0	4.6	5.5				
Potassium sulphate	Stand.....do	39.0	30.1	30.7	29.1	28.3	16.3	26.9	22.7	27.9	31.3				
Do	Wilt.....do	82.0	83.3	72.0	72.3	72.0	54.0	41.0	51.0	65.9	74.5				
Do	Marketable yield,[5] pounds	9,232	7,365	8,335	7,001	6,012	4,212	3,677	4,120	6,244	6,607				
	Unmarketable:														
Do	Undersized.....per cent	10.2	12.8	12.6	14.5	42.8	38.3	29.0	38.6	24.8	22.9				
Do	Scabby.....do	0	3.1	6.1	8.1	5.0	1.7	2.9	5.2	4.0	5.5				

[1] One plat.
[2] Average of 3 plats.
[3] Average of 6 plats.
[4] Average of 9 plats.
[5] Per acre.

CONDENSATION AND COMPARISON.

With fertilizer	Stand.....per cent	38.0	30.7	32.3	29.7	25.7	19.1	26.4	25.6	28.4					
Without fertilizer		29.5	31.0	34.7	30.0	29.5	31.0	34.7	30.0		31.3				
With fertilizer	Wilt.....do	86.0	81.2	76.3	68.3	69.6	58.0	51.3	48.1	67.3					
Without fertilizer		79.0	70.0	75.0	74.0	79.0	70.0	75.0	74.0		74.5				
With fertilizer	Marketable yield per acre, pounds.	9,355	7,707	7,271	6,953	8,122	4,185	4,459	4,856	6,612					
Without fertilizer		7,939	6,445	5,772	6,272	7,939	6,445	5,772	6,272		6,607				
	Unmarketable:														
With fertilizer	Undersized.....per cent	17.1	18.6	16.6	17.8	32.7	28.7	37.6	37.8	25.8					
Without fertilizer		21.4	24.2	25.5	20.5						22.9				
With fertilizer	Scabby.....do	3.6	6.6	4.1	6.1	8.5	5.5	2.9	2.1	4.9					
Without fertilizer		5.1	6.4	4.7	5.7	5.1	6.4	4.7	5.7		5.5				

The results of various methods of tillage and green manuring and the same methods with applications of potassium sulphate, potassium chlorid, and superphosphate show some significant differences. The most notable of these is the rather uniformly higher yields with superphosphate under all conditions of tillage and the uniformly better yields in proportion to stand which were obtained by applying the fertilizer in March over applying fertilizers at planting time. Deep plowing showed better results than shallow, and green manure gave generally better yields than were obtained from the bare fields.

THE USE OF VARYING QUANTITIES OF SUPERPHOSPHATE.

An experiment was conducted to determine the effect of applying superphosphate at different rates on land to which various tillage methods were applied. Each of the eight plats used in the experiment contained one-tenth of an acre. The results are given in Table II.

TABLE II.—*Results obtained with potatoes on land treated with varying quantities of superphosphate at the Delta Experiment Farm in 1912.*

	Treatment.							
	Plowed 12 inches deep.				Plowed 6 inches deep.			
	Green manure.		Bare.		Green manure.		Bare.	
Superphosphate per acre....pounds..	600	1,200	600	1,200	400	800	400	800
Stand.........................per cent..	34.7	34.0	31.7	38.7	44.9	36.3	36.3	33.6
Wilt..............................do....	97.0	81.0	75.0	50.0	84.0	77.0	77.0	80.0
Marketable yield per acre....pounds..	8,805	7,105	10,402	9,030	8,575	8,105	9,360	8,555
Unmarketable:								
Undersized.............per cent..	21.9	15.3	12.9	20.9	23.6	18.6	21.7	39.8
Scabby.....................do....	8.0	2.4	2.6	4.5	11.8	9.9	10.3	11.1

It is seen from Table II that varying the rates of superphosphate application resulted in no consistent differences in yield. The growth of haulm, however, was noticeably increased by the heavier application.

ACIDULATION OF IRRIGATION WATER.[1]

With a view to studying the effect of acidulating the irrigation water on the growth of potatoes and more particularly on the action of the scab organism, *Oospora scabies*, an experiment was conducted on four tenth-acre plats in field F. Commercial sulphuric acid was used. The method used consisted in the placing of a plank 10 inches wide and 6 feet long in the ditch at the head of each plat, the plank being pegged with the upper end 2 inches under water and with a fall of 4 inches to its length. Carboys containing a weighed quantity of acid were placed at the head of each plank with stoppers arranged to drop the acid at a rate designed to empty the carboys in six hours. A green-manure crop was plowed under on all the plats in early spring. The acid applications were made at the time when the tubers were beginning to form. The results are given in Table III.

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[1] This work was planned in accordance with suggestions of Mr. Karl F. Kellerman, Physiologist in Charge of the Office of Soil-Bacteriology and Plant-Nutrition Investigation.

TABLE III.—*Results of acidulation of irrigation water on potatoes at the Delta Experiment Farm in 1912.*

	Depth of plowing.			
	12 inches.	6 inches.	12 inches.	6 inches.
Rate of acid application per acre........pounds..	500	500	900	900
Stand........per cent..	32.3	31.4	30.9	36.8
Wilt........do....	58.0	69.0	64.0	70.0
Marketable yield per acre........pounds..	5,212	5,992	4,247	5,622
Unmarketable:				
Undersized........per cent..	13.4	24.2	18.5	31.8
Scabby........do....	10.6	7.2	9.4	4.4

While the results of acidulation show no increase in yield or reduction in scab, they give other indications which are of interest. These applications were made when the tubers were beginning to form, so that the percentage of stand has no relation to the application of acid. The immediate effect of the acid was a marked increase in the vegetative vigor of the plants. This stimulation continued during the remainder of the growing period, so that at harvest time the haulm was double that of any other plats in the field. The wilt infection on these plats was not only uniformly lower than on the rest of the field, but the growth of the infected plants was much less depressed. When the infected haulms on the rest of the field were dead, the infected plants on the acid-treated plats were still alive and with a large portion of their total leaf area green. These results, taken in conjunction with the lateness of the application, the moderate price of sulphuric acid, and the ease of application, suggest a promising field for further work.

DEPTH-OF-PLOWING TEST.

An experiment to test the effect of plowing at varying depths was conducted on field G. The plowing was done in March, the depths being 6, 12, and 18 inches. The potatoes were planted in June at a uniform depth of 6 inches. Each part of the experiment was duplicated on quarter-acre plats, so that each result given in Table IV is the average of two plats.

TABLE IV.—*Results obtained with potatoes at three different depths of plowing at the Delta Experiment Farm in 1912.*

	Depth of plowing.		
	6 inches.	12 inches.	18 inches.
Stand.......per cent..	30.6	28.6	29.4
Marketable yield per acre.......pounds..	4,370	5,405	5,978
Unmarketable:			
Undersized.......per cent..	22.5	17.7	16.7
Scabby.......do....	5.3	7.2	5.6

The yields, as shown in Table IV, increased with the depth of plowing, but the difference between th e12 and 18 inch plowing was probably not enough from the standpoint of one season's yield alone to justify the added expense of the 18-inch plowing.

DEPTH-OF-PLANTING TEST.

On field I an experiment in depth of planting in connection with two depths of plowing was tried. Alternate lands were plowed, respectively, 6 and 12 inches deep in March, and potatoes were planted in June, 4 and 8 inches deep on each kind of plowing. Eight half-acre plats were used in this test. The yields of marketable tubers per acre are shown in Table V.

TABLE V.—*Yields of marketable potatoes obtained from planting at different depths at the Delta Experiment Farm in 1912.*

	Treatment.							
	Plowed 12 inches deep.				Plowed 6 inches deep.			
	Green manure.		Bare.		Green manure.		Bare.	
Depth of planting.......inches..	4	8	4	8	4	8	4	8
Yield per acre.......pounds..	6,822	5,610	7,055	7,096	3,264	4,091	5,502	7,057

It is seen that with shallow plowing deep planting gave better results than shallow planting and that the results on the deep-plowed plats were contradictory.

COMPARISON OF LOCAL AND IMPORTED SEED.

Conditions for storing seed potatoes in the delta region are ordinarily not favorable. As there are no facilities for cold storage or for storing in pits, seed carried over from harvest to planting time is frequently weakened by sprouting. In order to determine the effects produced by using locally grown seed as compared with those resulting from the use of seed of the same variety shipped in from Oregon at planting time, an experiment with the two classes of seed was conducted on 22 tenth-acre plats. The seed imported from Oregon had been stored there in pits during the winter of 1911–12. Four plats of this seed were planted, two on land plowed 6 inches deep and two on 12-inch plowing. In the same series, nine plats plowed 6 inches deep and nine plats plowed 12 inches deep were planted to locally grown seed. The results are given in Table VI.

TABLE VI.—*Results obtained with potatoes grown from Oregon seed and from locally grown seed at the Delta Experiment Farm in 1912.*

	Oregon seed.		Locally grown seed.	
	Deep plowed.	Shallow plowed.	Deep plowed.	Shallow plowed.
Stand......per cent..	39.1	37.4	31.0	30.0
Wilt......do....	83.0	81.5	70.0	74.0
Marketable yield per acre......pounds..	10,204	9,440	6,445	6,272
Unmarketable:				
Undersized......per cent..	37.6	15.6	24.2	20.5
Scabby......do....	5.1	6.6	6.4	5.7

Table VI shows the differences in yield between pit-stored Oregon seed, sound and unsprouted, shipped in at planting time, and local seed weakened by sprouting. The yield from Oregon seed was decidedly higher and the stand was better. It is also noticeable that deep plowing again gave better results than shallow plowing.

SUMMARY.

The work conducted on potatoes at the Delta Experiment Farm in 1912 resulted in several important indications. Some of the more prominent facts noted are the following:

(1) Of the three commercial fertilizers used, superphosphate was the only one which markedly increased the average yields as compared with those obtained from the unfertilized plats.

(2) Better average results were obtained from the use of commercial fertilizers when the application was made in March than when the fertilizer was applied at planting time, in June.

(3) Plowing under a green-manure crop of barley resulted in increased average yields.

(4) The yields were generally better on 12-inch plowing than on 6-inch plowing.

(5) No consistent yield differences were obtained where superphosphate was applied in varying quantities. The growth of haulm, however, was increased by the heavier applications.

(6) Acidulation of the irrigation water with sulphuric acid resulted in no appreciable reduction in the action of potato scab and no in-

crease in yield, but the vegetative vigor of the plants and their resistance to wilt were markedly increased.

(7) In the test of 6, 12, and 18 inch plowing the yield increased with the depth, but the difference between the 12-inch and the 18-inch plowing was not sufficient to justify the added expense of the latter.

(8) On the shallow plowed land 8-inch planting gave higher yields than 4-inch planting, but no consistent difference in yield was noted on the deep-plowed land.

(9) Decidedly higher yields were obtained from sound Oregon seed than from locally grown seed, the difference appearing to be due to the deterioration of the locally grown seed resulting from improper storage.

(10) With the exception of the plats treated with sulphuric acid no consistent differences were shown in the wilt percentages, nor were any consistent differences shown in the scab percentages.

(11) One significant feature of the season's work was the uniformly thin stand on the fields. An examination of the plats following planting time showed that the decrease in stand on the old land was due to the very rapid rotting of the seed in the ground. The investigations along this line during the crop season of 1912 lead to the conclusion that the rotting of the seed pieces, resulting in thin stands and weak plants, is perhaps the most important factor causing decrease of yield.

SILVER SCURF, A DISEASE OF THE POTATO.[1]

By I. E. Melhus, *Pathologist, Cotton and Truck Disease and Sugar-Plant Investigations.*

INTRODUCTION.

It seems desirable to call the attention of potato growers to a disease of the potato which, though little known, is becoming widespread in the United States. This is the silver scurf, a tuber trouble caused by a species of Spondylocladium which attacks and destroys the periderm, causing discoloration and loss of moisture. According to information in hand it seems to have secured a foothold throughout the Eastern States without its presence being generally recognized. Introduced in all probability from Europe, it has spread rapidly and will have to be reckoned with as one of the factors in the deterioration of this crop. While the inconspicuous appearance of silver scurf has permitted it to be overlooked, it can readily be recognized after a little experience, and everyone interested should learn to distinguish this disease from the several others which occur on potato tubers.

APPEARANCE OF DISEASED TUBERS.

Silver scurf in its early stages of infection under moist conditions causes blackish olive patches on the surface of the potato, which may, and often do, cover considerable areas. This more or less superficial growth is the brown-mold stage and consists of the conidiophores and conidia of the fungus. This stage is well shown in figure 1. In the later stages of the development of the disease small black sclerotia are formed on the infected areas instead of the superficial growth of conidiophores. The surface of the discolored areas when clean takes on a silvery or glistening appearance, which is due to the raising of the cells of the outer layers by the mycelium of the fungus. This disfiguration of the surface is later followed by depressed patches of greater or less extent. The early stages in the formation of such spots are shown in figure 2, while the late stages are evident in figure 3. As the disease progresses the infected areas increase in diameter and the fungus penetrates deeper into the tuber. As a result it is not uncommon to find the whole surface of a tuber discolored, shrunken, and shriveled like the lower tuber in figure 3, while the outer layers of the periderm are loose and sloughing off.

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[1] Issued May 17, 1913.

DESCRIPTION OF THE FUNGUS.

The fungus causing silver scurf has two more or less markedly distinct stages in its development: The brown-mold stage (fig. 1, *a*, *b*, and *c*), which appears first and consists of the conidiophores and conidia, and the sclerotial stage, which follows later and consists of numerous small black sclerotia buried in the outer cells of the discolored areas. The relation of the sclerotia to the cells of the outer skin of the potato is shown in figure 4. When viable spores are placed in water at room temperature, they push out germ tubes in the manner shown in figure 1, *c*. These may penetrate the periderm and later the parenchyma, according to Frank. It has been reported by Johnson that sclerotia are even produced in the cells of the parenchyma and that the fungus grows readily on the cut surface of the potato. The writer has also observed the fungus fruiting on cut sur-

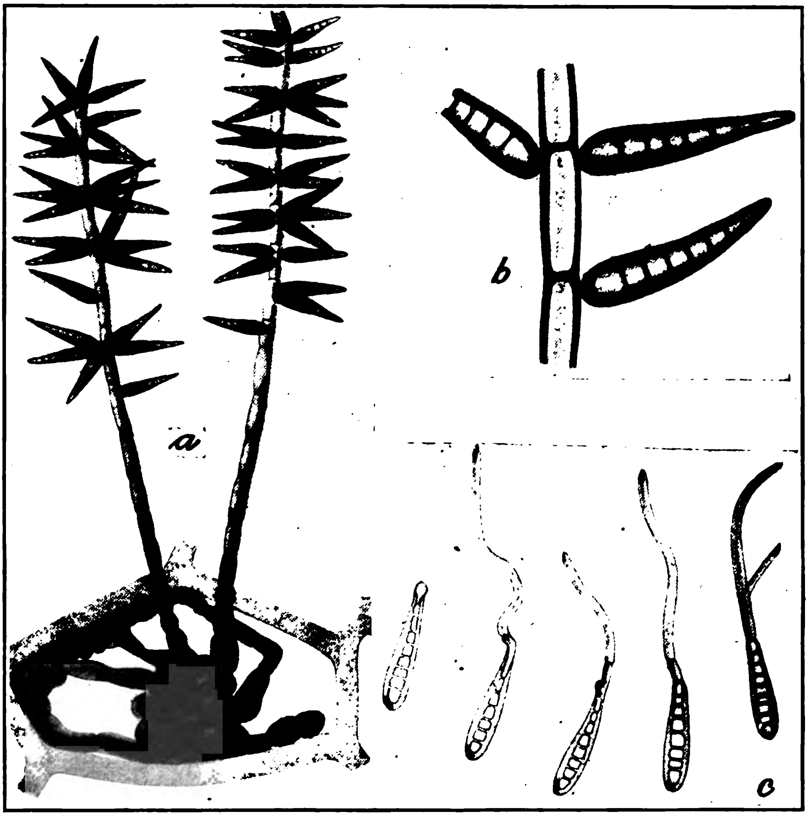

FIG. 1.—The brown mold stage of *Spondylocladium Atrovirens*. (*a*) The fruiting organs of the fungus. (*b*) A portion of conidiophore with attached conidia. (*c*) The several-celled spores, which usually put out a germ tube from the pointed end of the spore. (After Appel and Laubert.)

faces of potatoes. As the fungus spreads in the tissues it loosens the surface layers, causing the white silvery color. Later the surface layers slough off, carrying with them numerous sclerotia that infect the soil. In moist conditions the fungus fruits in from four to five days after the spores have germinated. The conidiophores may spring either from the mycelium in the tissues or from a sclerotium, in the manner shown in figure 1, *a*. The conidiophores are dark brown, rather tall, being about 120 microns long and 4 microns in diameter. (See fig. 1.) The spores are borne in rather irregular whorls on the upper portion of the conidiophore. The spores are dark brown, obovate, 5 to 7 celled, and about 40 microns in length by 8 in diameter. Nothing is known as to the longevity of the spores or the sclerotia. It is very probable that both are quite resistant and may therefore be important factors in facilitating the spread and continuance of the disease. It has been shown by Eichinger that the germ tubes and mycelium grow from the light, showing a negatively heliotropic reaction.

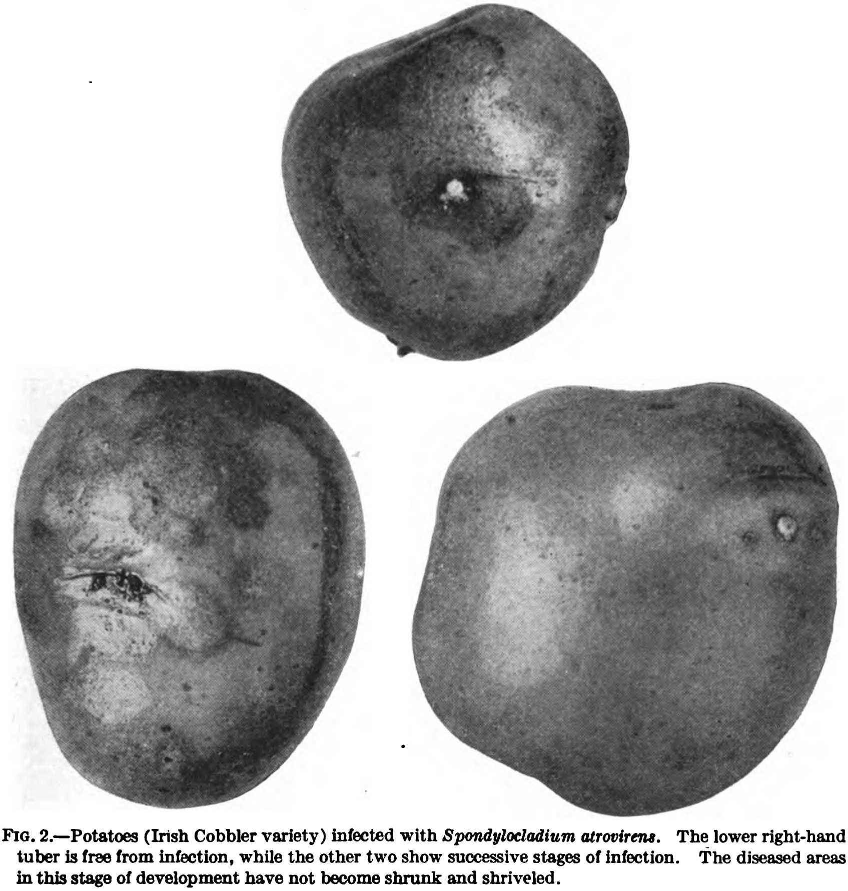

FIG. 2.—Potatoes (Irish Cobbler variety) infected with *Spondylocladium atrovirens*. The lower right-hand tuber is free from infection, while the other two show successive stages of infection. The diseased areas in this stage of development have not become shrunk and shriveled.

The sclerotial stage was until recently thought to be due to another fungus called *Phellomyces sclerotiophorus*. Black sclerotia, 8 to 16 microns in diameter, are formed more often in the surface layer of cells (fig. 4), although, according to Johnson, they may also be produced in the deeper layers of the periderm and parenchyma. From this observation it would seem that the fungus is able to attack any part of the tuber, a fact tending to show its parasitic nature.

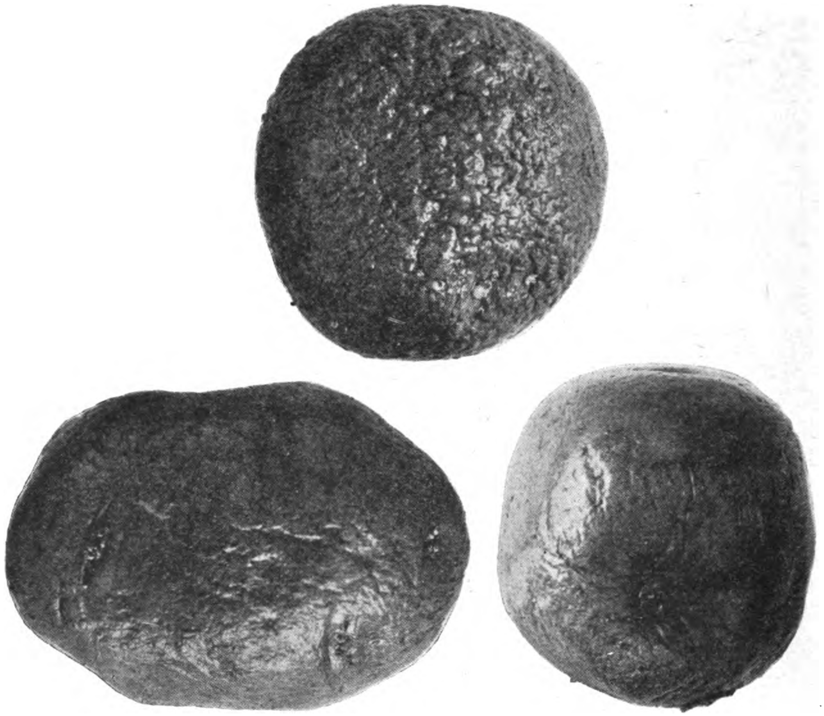

FIG. 3.—Later stages of silver scurf infection in the same variety of potato as shown in figure 2. It is a very common occurrence to find such infections as shown in the lower right-hand tuber. The effect of this disease on the potato is clearly shown in the upper tuber. The surfaces are shriveled, due to the loss of moisture and sloughing off of the protective covering.

The fungus causing silver scurf has been described as *Spondylocladium atrovirens* by Appel and Laubert. The spores are reported to be "4–8 (Meist 6–9) Querwänden, 7, 8–11, 9; 36–61, 5, im Mittel 10:46 μ." Clinton found that the species he studied had smaller spores. The writer has also found that the spores are not nearly as large as reported by Appel and Laubert. Whether this difference in the size of the spores is sufficient cause for considering the American species different from the European one is not clear at the present time. According to Clinton it has been suggested by Appel that there may be at least two forms, one having larger spores than the other. A study of this matter is in progress.

This disease was called "Fleckenkrankheit" and also "Phellomyces-Faule" by Frank in 1897 and 1898, respectively. It can hardly be considered a spot disease, since it very often involves the whole surface of the diseased tuber. Recently it has been shown by Appel and Laubert that *Phellomyces sclerotiophorus*, the fungus described by Frank, is only the sclerotial stage of *Spondylocladium atrovirens*. This fact naturally excludes the possibility of using the name applied to this disease by Frank. More recently the disease under consideration has been called "scab," "dry rot," "dry scab," and "scurf." It does not seem wise nor justifiable to apply the term "scab" to this disease, since we already have three or four different kinds of scab. Furthermore, Spondylocladium does not cause symptoms comparable to those produced by Oospora, Spongospora, and Chrysophlyctis. As is well known, all of these parasites cause hypertrophy and cankers of the tissues infected. Such is not the case with Spondylocladium. On the contrary, it causes the death and shrinkage of the attacked cells and tissues. The term "scurf" has been applied by Clinton and is doubtless a better name than any used previously, because it is less confusing and is more descriptive of the symptoms of the disease. The light, glistening, silvery discoloration of the surface of the washed potato due to the Spondylocladium infection is a very common and characteristic symptom. In view of this fact the name "silver scurf" is proposed for this disease.

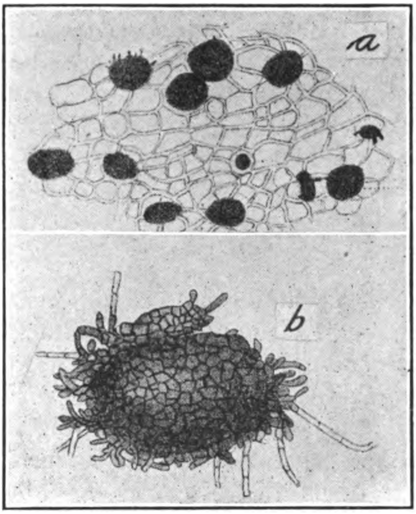

FIG. 4.—Sclerotia of silver scurf. (*a*) The surface view of an infected area, showing the sclerotia and their relation to the outer layer of cells. (*b*) An isolated sclerotium, much enlarged, in the early stages of germination. (After T. Johnson.)

DISTRIBUTION OF THE DISEASE.

Silver scurf has been known in Europe since 1871, when it was apparently first found and described by Hertz in Austria. In 1897–98 it was reported in Germany by Frank as causing a sort of dry rot. Johnson in 1903 reported it as causing considerable dry rot in Ireland and the following year it was reported in England by Smith and Rea. Up to the present writing silver scurf has been reported from only one locality in the United States. Clinton found it in Connecticut "on a few tubers among the many varieties to be tested that year at the station." It should be noted that he believes the disease was introduced into Connecticut on imported varieties.

The disease was first found by the writer in the fall of 1912 in two barrels of potatoes shipped from western New York to Washington, D. C. No count was made, but it was estimated that at least 10 per cent of these potatoes was infected. Later it was found on Irish Cobblers bought in the local market early in December, 1912. These potatoes were raised in Maryland about 15 miles from Washington. Each tuber was examined and it was found that 56 per cent of this collection (2 bushels) was infected with silver scurf. More recently the disease has been found on potatoes from Virginia, Vermont, Maine, Kansas, West Virginia, New York, Florida, and Wisconsin, which tends to show that it may be quite generally distributed throughout the eastern half of the United States. This is especially interesting as showing its rate of spread, since it was first observed in this country in 1907 by Clinton and could hardly have existed long prior to this date without being observed by pathologists.

IS IT INJURIOUS?

It has been quite definitely established by earlier workers that Spondylocladium does not attack the foliage of the potato plant, but is confined chiefly to the potato tuber. Although the morphology of this fungus has been beautifully pictured and well described, very little is known regarding its effect on the tuber further than a few general statements occurring in the literature, none of which are based on experimental evidence. It is not probable that silver scurf is as destructive as our common Oospora scab, yet the following statements tend to show that some damage does occur from this disease.

According to Frank, silver scurf has the same effect on the potato as the Fusaria. This comparison is hardly justifiable in the light of our recent contributions on the various parasitic species of Fusaria, although it conveys some idea as to its destructiveness. Appel and Laubert are of the opinion that Spondylocladium has little destructive effect on the potato. It has already been pointed out that the fungus studied by Appel and Laubert may be different from the one common on the potato in America. Johnson, of Ireland, believes that "it is a true parasite, and apparently may do considerable unsuspected damage to the potato crop in Ireland. It may give rise to a skin disease or 'scab' of the potato tuber, and in a more advanced stage of attack to a 'potato rot'." Massee recommends that infected tubers should not be used for seed purposes. By Bohutinsky it has been stated that a species of Helminthosporium is the cause of leaf-roll. The fungus reported as causing leaf-roll has since been identified by

Appel as *Spondylocladium atrovirens.* This is also quite apparent from Bohutinsky's figures. It does not seem very probable that silver scurf is the cause of leaf-roll, but it may well be that it causes abnormal plants in certain instances. The fact that it disfigures the tuber and causes abnormal shrinkage is alone sufficient to involve considerable loss where tubers are to be used for human consumption after a considerable period of storage. It is not without destructive effect on the early varieties as well, and especially with red-skinned ones. A shipment has come to the writer's attention in which marked disfiguration occurred in the Bliss Triumph variety grown in the South for the early market. The tubers in some cases were so badly infected that the red color, so characteristic of the sound tuber, was no longer in evidence. In such cases considerable loss occurs, due to the sorting and to the decrease in market value of the infected tubers.

The big question in connection with silver scurf has to do with the effect it will have on the tubers used for seed purposes. What will be the effect on the yield and general vigor of the crop grown from seed infected with this disease? What effect will it have on germination, and will the wounds or lesions due to Spondylocladium increase the susceptibility of the parent tuber to the ravages of wound parasites? Likewise, the relation of the fungus to the soil and the method of spread of the disease in storage are open questions. These are problems that can not be answered at present, but which merit careful consideration, especially where the disease is very prevalent and the tubers are held in poor storage for a considerable length of time.

POSSIBLE METHODS OF CONTROL.

It is of special interest to know whether this disease, confined as it is chiefly to the periderm, can be controlled by the well-known formalin treatment used for the Oospora scab. It is claimed by Johnson that such is the case. He treated tubers for one hour in an 0.8 per cent formalin solution (about 2 pints to 30 gallons of water) and planted the same. Other diseased tubers not treated were planted as checks. When the potatoes were harvested in the fall it was found that the treated tubers were free from disease, while those from the checks were infected with the brown-mold stage of Spondylocladium, indicating that the 0.8 per cent formalin solution either killed or materially inhibited the growth of the fungus.

The effect of the formalin and corrosive-sublimate treatment as a means of destroying silver scurf has also been tested in the laboratory of Cotton and Truck Disease and Sugar-Plant Investigations. Two varieties of potatoes, the Irish Cobbler and the Green Mountain, were washed and soaked in formalin or corrosive sublimate. Following this treatment the specimens were placed in moist chambers under conditions favorable for the fungus to fruit. In every case viable spores were produced from 2 to 12 days after treatment. The germinating capacity of the spores was determined by placing them in water for 24 hours. In every case the spores germinated.

As shown in Table I, neither corrosive sublimate nor formalin used twice as strong as in common practice for a period of five hours killed the fungus.

TABLE I.—*Effect of formalin and corrosive sublimate on silver scurf.*

Date.	Variety tested.	Number treated.	Fungicide used.			Result.	
			Name.	Strength.	Time of treatment.	Period in moist chamber.	Viable spores.
				Per cent.	*Hours.*	*Days.*	
Jan. 30	Irish Cobbler	50	Corrosive sublimate.	0.2	2	7	Present.
		25	Formalin	.4	2	7	Do.
Feb. 10	Green Mountain	10	do	.4	2	2	Do.
		10	Corrosive sublimate.	.1	1½	2	Do.
Feb. 11	do	10	Formalin	.4	5	12	Do.
		10	Corrosive sublimate.	.1	5	12	Do.
Feb. 12	Irish Cobbler	10	Formalin	.4	4	4	Do.
		10	Corrosive sublimate.	.1	4	4	Do.
Feb. 14	do	10	Formalin	.4	3	2	Do.
		10	Corrosive sublimate.	.1	1½	2	Do.
Mar. 20	Eureka	20	Formalin	.8	19	10	Do.
Mar. 21	do	20	do	.8	5	10	Do.

These data suggest that the ordinary formalin and corrosive-sublimate methods in vogue for controlling Oospora scab do not kill Spondylocladium. This is not surprising in view of the fact that the fungus produces numerous sclerotia and penetrates all parts of the periderm and in severe cases even extends into the parenchyma. Johnson used an 0.8 per cent solution of formalin and succeeded in preventing the reappearance of silver scurf. An 0.8 per cent solution of formalin is twice as strong as that commonly used in this country for Oospora scab. In the test on January 30, 1913, recorded in Table I, a double strength of corrosive sublimate (about 4 ounces to 15 gallons of water) killed the tubers, but the fungus developed viable spores after 7 days. On March 20, infected tubers were soaked 19 hours in an 0.8 per cent formalin solution and immediately placed in a moist chamber. The fungus produced viable spores after 10 days. It should also be noted that many of the eyes of the tubers were killed by this treatment. Neither does dry heat at 50° C. for 5 hours kill the fungus. This was learned in connection with numerous experiments planned to determine the effect of dry heat on tubers infected with *Phytophthora infestans*. Spondylocladium fruited from 4 to 10 days after the tubers had been subjected to 50° C. for 2 to 10 hours. If the potatoes were kept at 50° C. for longer periods their germinating capacity was injured. This tends to show that the viability of the fungus is even greater than that of its host. Experiments are in progress to determine further the value of formalin as a means of controlling this disease.

RELATION TO THE SEED-POTATO INDUSTRY.

In order to gain some idea as to the amount of silver scurf present on potatoes being used for seed purposes this spring, several days were spent examining the seed stock being planted in the vicinity of Norfolk, Va. A shipment of over 500 barrels raised in northern Vermont came to the writer's attention. These potatoes were shipped to Norfolk last November and stored at a temperature ranging from 40° to 65° F., according to the statement of the owner. Some Phytophthora rot was in evidence in this stock. The combination of high temperature and moist condition, the latter due to the soft-rot, favored the development of Spondylocladium. Both the brown-mold and the sclerotial stages were readily detected, especially the former. Three barrels were sorted with the following results:

First barrel (by measure), infection with silver scurf......	40 per cent.
Second barrel (by measure), infection with silver scurf....	2 per cent.
Third barrel (by measure), infection with silver scurf......	50 per cent.

It was impossible to examine every potato in any considerable number of barrels, so 17 other barrels from the collection of over 500 were dumped separately and the amount of silver scurf estimated. This was not especially difficult, because of the prevalence of the brown-mold stage, which is quite conspicuous when well developed. The amount of silver scurf ranged from about 1 to 90 per cent. When the amount of soft-rot was great the percentage of silver scurf was less, due, it is believed, to the excessive moisture present, a condition unfavorable for the rapid spread of the fungus. In 10 of the barrels examined the amount of silver scurf ranged from 25 to 90 per cent and in the remaining 10 it varied from about 1 to 25 per cent.

Another collection, consisting of 25 barrels of potatoes which had just arrived from Aroostook County, Me., showed about 25 per cent of silver scurf. It was strikingly noticeable in this collection that the disease was not as far advanced as in the earlier collection examined, and only the sclerotial stage was in evidence. Still another collection from Maine needs mention. It consisted of 15 barrels grown in the south-central part of the State. This collection was remarkably free from late-blight, but showed 35 per cent of silver scurf. In three of the barrels that were sorted the following amount of Spondylocladium were found:

First barrel (by measure), infection with silver scurf	30 per cent.
Second barrel (by measure), infection with silver scurf	40 per cent.
Third barrel (by measure), infection with silver scurf	35 per cent.

Three of the other barrels were emptied and the amount estimated. It was approximately the same as in the three barrels sorted. The infection in this collection had progressed farther than in the shipment examined from Aroostook County. This was possibly due to the different storage conditions to which the two lots of potatoes had been subjected. Small collections of other lots of seed potatoes from Maine on which silver scurf was also present were brought to the writer's attention, but the quantity examined was insufficient to make any just estimate as to the amount of this disease.

Although only comparatively few lots of seed have been examined, yet it is sufficient to show that silver scurf is a common disease on potatoes in Maine and Vermont, two States that furnish a considerable amount of seed to various sections of the United States, and since it is present on the seed going out from these two States it is possible that silver scurf is quite generally distributed in the eastern half of the United States.

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[Cir. 127—C]

THE DASHEEN, A ROOT CROP FOR THE SOUTHERN STATES.[1]

By Robert A. Young, *Scientific Assistant, Office of Foreign Seed and Plant Introduction.*

INTRODUCTION.

While Mr. O. W. Barrett was connected with the Porto Rico Agricultural Experiment Station previous to 1905, he brought together and grew a large collection of the tuberous-rooted aroids which are important food plants of the Tropics. He drew attention to the possibilities of these aroids in a bulletin published in 1905,[2] and when he entered the Office of Foreign Seed and Plant Introduction he assembled a still larger collection from different parts of the world. Several field trials of them were made at Gotha, Fla., and Gough, S. C. The results of these early experiments in the United States were published in 1910.[3]

As a result of these preliminary trials, in which, naturally, many of the introduced varieties failed, one of the forms, the dasheen, proved to be of unusual promise.

This paper deals with some of the more important features of the field experiments with the dasheen under the writer's direct supervision, as well as some greenhouse experiments in the production of blanched shoots, and with the results of many experiments in the cooking and preparation of the shoots and tubers for the table.

In 1909, from a small experimental plat grown near Charleston, S. C., it became apparent that the dasheens, which are closely allied to the taros of Hawaii, China, and Polynesia, were well adapted for culture in certain of the moist lands of the South. Since that time the endeavor has been to propagate a stock of the best varieties sufficient to make possible their distribution on a large scale. Certain varieties secured originally from the island of Trinidad and other parts of the West Indies were found to be satisfactory in yield and to be of higher quality than others in the collection. These are the varieties to which particular attention is now being given, though many others are under investigation.

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[1] Issued May 17, 1913.

[2] Barrett, O. W. The yautias, or taniers, of Porto Rico. Porto Rico Agricultural Experiment Station, Bulletin 6, 27 p., 4 pl., 1905.

[3] Barrett, O. W., and Cook, O. F. Promising root crops for the South. U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 164, 43 p., 1910.

The origin of the word "dasheen" is somewhat obscure, but Mr. Barrett, who has spent some time in Trinidad, as well as in other parts of the West Indies, states that it originated in Trinidad and suggests an explanation which seems at least probable. Two possible derivations are given: "de la Chine" or "da Chine" (the latter pronounced dah-sheen, being the form in the patois of the French West Indies), meaning "from China"; also "des Indes" (pronounced daze-eend, or daze-and), meaning "from the Indies." Mr. Barrett believes the former to offer the more likely explanation.

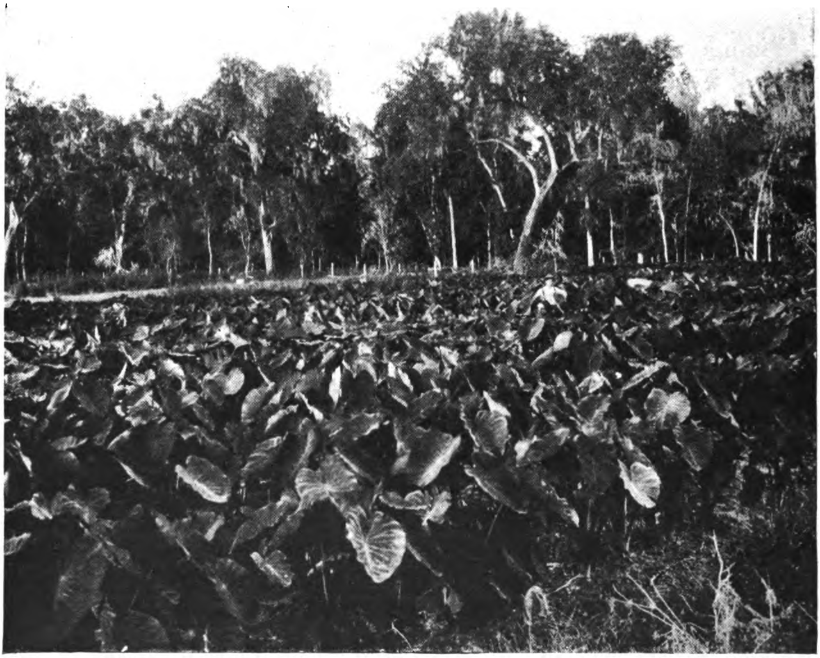

FIG. 1.—A field of dasheens as it appears in September. These broad-leaved plants when full size stand 4 to 6 feet high and shade the ground completely. The seed tubers are planted in March; the harvest takes place in October. This planting is on hammock land at the United States Plant Introduction Field Station, near Brooksville, Fla.

The dasheen is also known in various parts of tropical America under the names "malanga," "eddo," "coco," "taya," and "tanier" (also spelled "tannia" and "tanyah"). These names are likewise often applied to the yautia and taro.

DESCRIPTION.

Dasheen plants are members of the botanical family Araceæ, to which belong also the calla, the Indian turnip, and the caladium, or elephant's-ear. The dasheen belongs to the genus Colocasia, but there has not as yet been sufficient botanical work done on this group to make it possible to determine the species. The leaves of the dasheen are shield shaped (figs. 1 and 2), like the caladium and the tanier of the South, and contain the same acrid principle that characterizes the Indian turnip and most other plants of this family. They should never be tasted raw. The tubers of the most promising Trinidad varieties are free from this acridity even in the raw state, but because of the possibility of tubers of an acrid variety being mixed with these it is best never to taste them uncooked. In cases of the accidental tasting of acrid tubers or leaves, lemon juice in a little water is found to alleviate the ill effects.

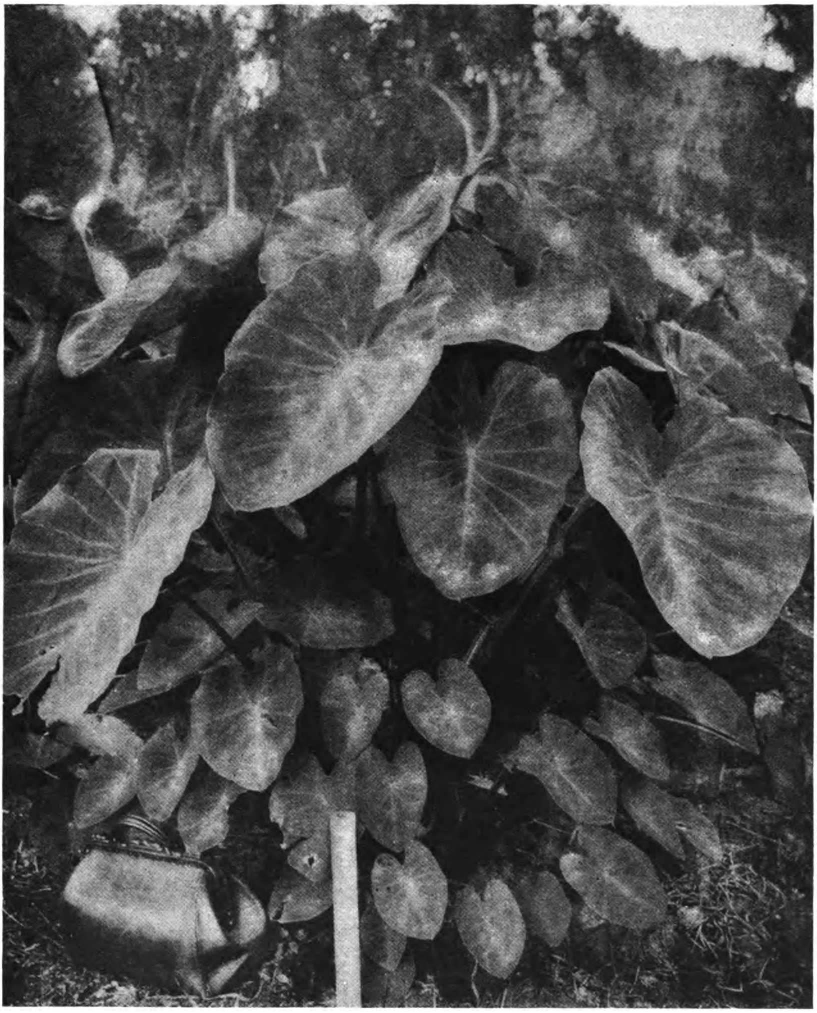

FIG. 2.—A hill of the Trinidad dasheen. One dasheen plant will cover a square yard of ground and produce 4 to 10 pounds of tubers on good rich soil. This variety is one of the best flavored yet introduced.

If dasheens are handled in water in scraping or paring them for cooking, a level teaspoonful of sal soda should be added to each quart of water. The outer part of the tubers contains an irritant that causes the hands to sting in somewhat the same way as the mouth and throat from the eating of raw, acrid leaves or tubers. The hands are affected in this way even in the case of tubers that are not acrid to the taste. If water is not used while scraping them, it is best to wash the hands afterwards in soda water of the strength mentioned.

The dasheen corms and tubers[1] are similar to the potato in composition, but they contain less water, and in consequence the content of starch, as well as of protein, is roughly a half higher than in the potato.[2] In addition they possess a very agreeable, nutty flavor. Remarkable digestibility has long been attributed to the aroid tubers, and in Hawaii, as well as in other countries where they are grown, their use for invalids is often prescribed. The starch grains of the taro and dasheen are among the smallest known in all food plants, and this is thought by some to account in part for the ease of digestion.

RESULTS OBTAINED IN CULTIVATION.

Experiments on a small scale in growing the dasheen have been made at a number of points in the Northern States, even as far north as New York, but while tubers were usually produced they were comparatively small. The reports received do not at present warrant the Department of Agriculture in recommending dasheens for cultivation, even in vegetable gardens, north of the Carolinas. Future experiments, however, may show that this limit can be extended.

The first marked success in the experimental growing of dasheens in this country was in 1909 in South Carolina, to which reference has already been made. Forty bushels were harvested from one-tenth of an acre. The next year the propagation of the dasheen was begun at the Plant Introduction Field Station, Brooksville, Fla., but it was not until the season of 1912 that a crop large enough for a wide distribution was raised. Seven acres were grown that season, though more than 2 acres of this were on what proved to be very unsuitable land. The clay subsoil came almost to the surface in many places and in others formed "pockets" which held the excessive rainfall, to the detriment of the plants.

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[1] Each hill of dasheens contains one or two rather large, somewhat spherical corms, around which develop numerous cormels. The latter are popularly called "tubers." For the corm, however, because of the differences in size and form between it and the cormels, it is found convenient to retain the technical name in common usage.

[2] An average of 11 analyses of dasheens by the United States Department of Agriculture gives 27⅔ per cent of carbohydrates (starches and sugars) and 3 per cent of protein. For the white potato the generally accepted figures are 18 per cent of carbohydrates and 2.2 per cent of protein. The sweet potato approximates the dasheen in carbohydrates, but it is even lower than the white potato in protein.

A total yield of about 1,200 bushels was obtained. Of this quantity approximately one-third consisted of marketable tubers (fig. 3), one-fifth of corms, one or two of which occur in each hill, and the remainder, nearly one-half, of small tubers, which have been distributed for planting. About one-half of these small tubers would be large enough for the home table, but are too small for the market. These may be used for stock food, either raw or cooked, in connection with other food. No careful experiments have as yet been made, however, in this country[1] upon which to base definite statements relative to the use of dasheens for stock food.

The corms, which sometimes reach a weight of nearly 5 pounds each, are usually of a quality fully equal to the tubers and are excellent when baked, though occasionally one is found that, even when thoroughly cooked, proves a little too firm to be palatable. It is believed, however, that this undesirable character can be eliminated by using for planting tubers from only such plants as produce corms of satisfactory quality.

The corms may be converted into flour, which can be made into soups and gruels. Dasheen flour when used with wheat or rye flour makes most delicious pancakes, biscuits, and bread. The pancakes do not become heavy by standing. Some 3,000 pounds of flour were produced during the season of 1912–13 from 200 bushels of corms and tubers and this flour is now being used experimentally in cooking and baking.

Dasheen corms may also be forced with bottom heat in a greenhouse, and the blanched shoots, by special cooking to remove the acridity, may be used like asparagus. The shoots are very tender and have a delicate flavor, suggestive of mushrooms. There are probably few plants so well suited for forcing purposes as the dasheen. Experiments carried on at the greenhouses of the Department of Agriculture at Washington in 1912 and in those of the Battle Creek Sanitarium at Battle Creek, Mich., early in 1913, indicate that five to eight crops of these delicate shoots can be harvested. The first cutting can be made in 35 to 40 days after the corms are set in the sandy soil of the greenhouse bench, and subsequent ones at intervals of 10 to 14 days.

The tops of corms not utilized in any of the ways mentioned may be used the succeeding season for planting, and the basal part—a half or more—may be used for the table or for stock food.

While all of the tuberous growth of the dasheen is edible, the medium-sized or large tubers are especially adapted for use like potatoes. At present it seems probable that these will constitute the principal value of the crop, as these tubers when properly selected will doubtless command a much higher price than either the corms or the smaller tubers. The corms do not usually keep as well as the tubers and it is therefore advisable to utilize them as early as practicable after harvesting.

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[1] See U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 164, entitled "Promising root crops for the South," p. 16, 1910.

CULTURAL REQUIREMENTS.

The dasheen requires rich, sandy soil, very moist but well drained. The plant will not be greatly injured by occasional flooding for a short period. Such lands as the so-called hammock lands of Florida are especially adapted for the cultivation of this crop. Any low-lying sandy land that is fairly well drained, but still too wet for general field crops, can be used to advantage. On these low lands it would be advisable to plant on ridges.

Planting should be done as early in spring as the conditions of soil and climate will permit. This may be as early as the first of February in southern Florida and as late as the last of March or the early part of April in the Carolinas.

Preliminary experiments indicate that it does not pay to use very small dasheens for planting if larger tubers are available, as this may result in the yield being reduced by as much as 15 per cent. Tubers of 3 to 5 ounces in weight are preferable for planting. For field culture the tubers, unless very small or very large, are planted, singly and entire, from 2 to 3 inches deep in hills 3 feet apart, the distance between rows being 4 feet. This will permit horse cultivation. In cultivating during the summer the soil should be gradually drawn to the plants and the plants kept free from weeds; they usually require little cultivation after becoming large enough to shade the ground. Well-grown plants will reach a height of 4½ to 6 feet or more by midsummer.

The crop matures in about seven months, although the tubers can be utilized for home use in six months or less from planting. The harvesting of the main crop may be deferred a month or two, if desired, but if it is to be done at one time, in order to have warm, dry weather for the dasheens to dry properly on the ground, it should not be delayed till there is danger of frost. For this reason it will usually be best to harvest dasheens sometime in October. It will sometimes prove advantageous in practically frost-free localities or where the roots can be protected to leave them in the ground until wanted for use or until spring.

Where soil and climatic conditions are favorable, dasheens will produce from 4 to 10 pounds or more to the plant. Under experimental conditions at Brooksville, Fla., in different soils and in different seasons, the Department of Agriculture has secured yields ranging from 140 to 450 bushels to the acre. Satisfactory results have not been obtained, even in good soil, when two successive crops of dasheens are grown on the same ground.

The growing of a dasheen crop is probably no more expensive than that of a potato crop. Although the season for the dasheen is much longer than that for the potato, the large leaves of the former tend by shading to keep down weeds after midseason.

FERTILIZER.

Experiments made at the Porto Rico Agricultural Experiment Station[1] indicate that ordinary stable manure is better suited than commercial fertilizer for use in growing dasheens and other plants of this kind. Where there is a deficiency of potash in the soil, however, as in most of the sandy soils of the South, and especially where stable manure is not available, a fertilizer rich in potash should be applied. From 600 to 1,000 pounds to the acre may be used, the quantity depending upon the state of fertility of the soil. The fertilizer should be applied within a few weeks after planting, and a second application may be desirable in midsummer in some instances.

HARVESTING.

Harvesting, for the present at least, is more costly than for potatoes, because of the hand labor required in separating, cleaning, and sorting the tubers. A 10-inch plow has proved satisfactory for turning the plants over when the area grown is large enough to justify its use. Even on sandy land, however, the multitude of fibrous roots hold the soil so firmly that a clump of tubers can not be separated except by hand. The plants should be grasped by the tops and the clumps thoroughly shaken to dislodge as much of the soil as possible. They can then be broken apart by means of the tops, and in dry weather the tubers, with tops still attached, should be left on the ground to dry for four to six days.

It is highly desirable to harvest the crop during a dry spell, as it is of the utmost importance that the tubers have time to dry well in the open air before being stored. The tubers should not in any case be exposed to frost.

GRADING.

The grading of dasheens is of primary importance, especially where the grower wishes to build up a market among hotels and other discriminating consumers. The first grade should contain only perfect tubers of uniform size and shape, weighing approximately 4 to 5 ounces each (fig. 3). Some mechanical means of grading can no doubt be devised that will materially lessen the cost of handling. A very simple scheme where the quantity of dasheens is not too large is to make a wooden frame, say, 18 by 24 inches and 6 inches deep, with a bottom of parallel rounded slats or wooden rods at suitable distances apart. Rods of the diameter of a rake handle or slightly less will probably be found most satisfactory.

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[1] See U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 164, entitled "Promising root crops for the South," p. 12, 1910.

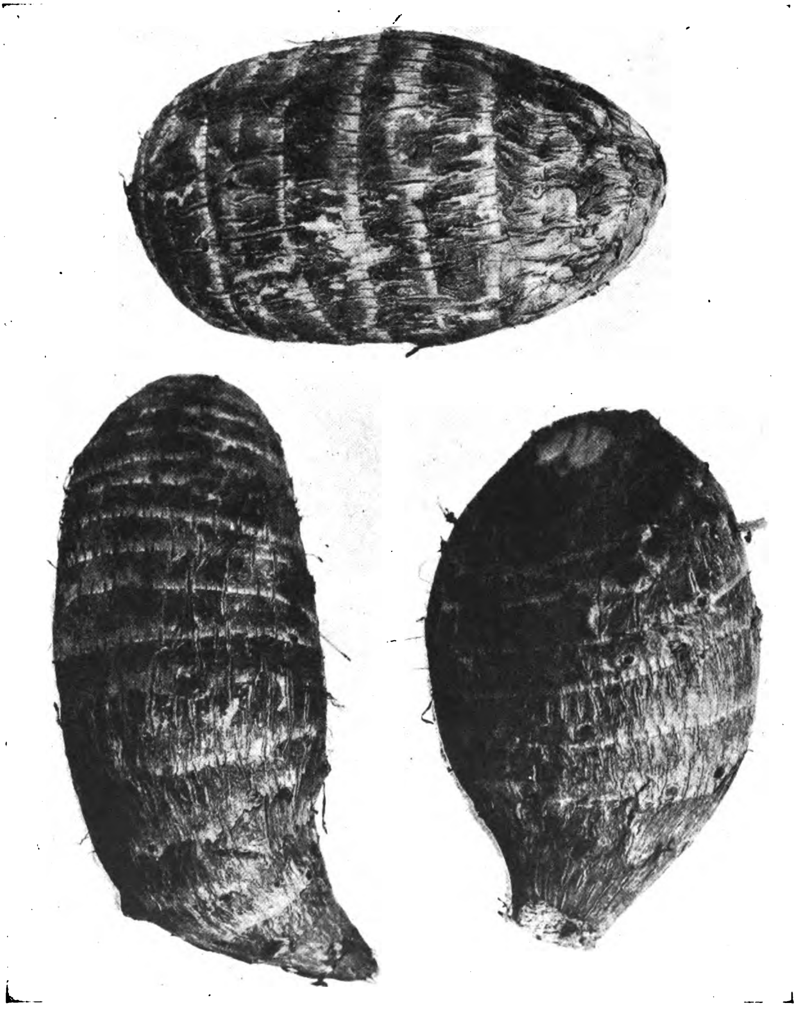

FIG. 3.—Dasheens for table use. These tubers contain 50 per cent more protein and starch than the potato, have a decidedly nutty flavor, and are very easily digested. They are formed in a compact cluster with smaller tubers, attached to and around a large central corm. Flour can be made of both corms and tubers, and the corms can also be forced for the production of blanched shoots for winter use. (Two-thirds natural size.)

For separating tubers too small for market the distance between the rods should be about 1¾ inches. A frame of the size mentioned can be readily handled by one man. If, however, the quantity of dasheens is large it will be desirable to have a stationary grader of larger dimensions. It should be placed on an incline, so that the larger tubers will roll off at the lower end. If more than two grades of tubers are desired, an additional set of rods or bars at either greater or less distances apart can be placed a few inches above or below, as may be necessary. In the use of any grading device and in the handling of dasheens generally, care should be taken, as in handling potatoes, not to bruise them.

On account of the variability in the form of dasheen tubers some handwork will probably always be necessary where careful grading is required, but the amount of this can be greatly reduced by adopting some plan such as one of those outlined.

STORAGE.

The question of the best method of storing dasheens to prevent them from decaying is still under investigation. At present they appear to be no more difficult to keep in storage than sweet potatoes. They will usually keep well if stored in a dry place at a temperature of about 60° F. where the air can circulate freely among them. It is believed that they will also keep if placed in dry sand or earth in a dry cellar having a temperature of 60° F. or a little less.

CONCLUSION.

From the interest that has already developed among southern farmers who have become even slightly acquainted with the dasheen, it seems probable that this crop is destined to become of importance to that section of the country. It can be grown as a summer crop in a region where the potato must be grown almost entirely as a spring crop, for it ripens its tubers in October and furnishes them for the table at a season when northern-grown potatoes have to be shipped in at prices relatively high, except in seaports. It is a good yielder, comparing favorably with the potato. If grown on well-drained land it is not injured as the potato is by unusually wet weather and is therefore suited for cultivation on lands where the potato would be a failure. Its culture on wet lands in the South where the water supply can be controlled by drainage or otherwise is a subject of further investigation.

The young tops when properly cooked can be substituted for spinach at a time when the weather is too hot to grow spinach. The blanched shoots obtained by forcing dasheen corms in the dark in a greenhouse or under other suitable conditions constitute an entirely new product, which is meeting with general approval. The nutty flavor of the tubers gives them a peculiar palatability which has struck the fancy of a large number of persons. The higher nitrogenous and starchy character gives them an advantage as food that would seem to make the plant, when compared with the potato, an even more valuable food producer.

RECIPES FOR THE PREPARATION OF THE DASHEEN.

This vegetable is a staple article of food for millions of people in tropical and subtropical countries. In general it is used in the different ways in which the white potato is used. It may also be candied like the sweet potato. The flesh of the corms and large tubers is frequently somewhat gray or violet when cooked, but this does not affect the flavor.

When uncooked dasheens are being scraped or pared they should be handled in water to which a teaspoonful of sal soda to the quart has been added, in order to prevent irritation to the hands.

BAKED DASHEENS.

Dasheens, large or small, may be baked like potatoes, in a quick oven. They should first be washed and scrubbed to remove the fibrous part of the skin. When practicable to do so it is often desirable to scrape the dasheens before baking, as they are then more convenient for eating and the soft crust which forms when they are properly baked is particularly delicious. The corms may be cut in half from top to base in order to lessen the time needed for baking. The time required is about the same as for potatoes of the same size. They should be served hot. Season with salt and plenty of butter, and pepper if desired. Gravy instead of butter may be used.

The dasheen when properly baked and served is mealy and the flavor is much like that of the white potato, but more or less suggestive of chestnuts. If not overbaked, the skin when properly scrubbed or scraped beforehand will be found of delicious flavor. As the dasheen is drier than the potato it requires more butter.

STUFFED DASHEENS.

Proceed the same as in baking, and when the dasheens are done follow the method used for stuffed potatoes, using more butter, however. If cream instead of milk is used for moistening, still better results are secured.

The corms are especially adapted for serving in this manner, but they should always be scraped and, unless quite small, may be cut in half. Instead of mashing dasheens it will always be found better to rice them with a potato ricer or to rub them through a coarse sieve.

SCALLOPED DASHEENS.

Pare raw dasheens and slice thin, putting in layers in a well-buttered baking dish, seasoning each layer with salt and butter and sprinkling each lightly with flour. Nearly cover with rich milk and bake.

This method of serving the dasheen will be found particularly well adapted for banquets or formal dinners, but in such cases individual baking dishes or casseroles should be used.

The above recipe may be varied by using less butter and adding grated cheese. Pepper may also be used in seasoning if desired. Cold boiled instead of raw dasheens may also be utilized in these recipes.

BOILED DASHEENS.

Large dasheens are preferable for boiling, though small ones may also be used. They should be boiled in the skin and may be served thus, or the skins may be removed before serving. Dasheens should not be boiled longer than potatoes of the same size, and they should never be pared before boiling.

MASHED DASHEENS.

On account of the somewhat mucilaginous character of dasheens they are not recommended for mashing in the ordinary way. They do, however, make an excellent dish when boiled in the skin, peeled, and riced, or put through a sieve, as previously mentioned. Rich milk or cream and a liberal quantity of butter should be used in seasoning when particularly good results are desired. It should be remembered that riced or mashed dasheens may be a little dark, especially when corms or large tubers have been used.

CREAMED DASHEENS.

Boil the dasheens in the skin and proceed as for creamed potatoes.

DASHEENS AS FILLING FOR FOWL AND OTHER MEATS.

2 parts of riced dasheen.
1 part of bread.
1 egg.
Butter, according to quantity of above.
Season to taste with salt, pepper, sage, and onion.

The dasheens should be boiled and riced in the usual way.

DASHEEN SOUP.

3 cups of boiling water.	3 tablespoonfuls of butter.
3 cups of milk.	Salt and celery salt to taste.
3 cups of riced dasheen.	Parsley or grated onion if desired.

Boil and rice the dasheens as described. Into a double boiler put the boiling water and add the milk and dasheen. Bring to a boil and cook for 5 to 10 minutes. Season and serve.

CANDIED DASHEENS.

Peel parboiled dasheens and cut into thick slices or strips; prepare a sirup made in the following proportions:

1 cup of sugar.	2 to 3 tablespoonfuls of butter.
2 cups of hot water.	Salt if desired.

Either granulated or brown sugar may be used. Cinnamon may be added if desired. Boil in this sirup in a covered dish until soft, and brown in the oven.

DASHEEN PIE.

Any recipe for sweet-potato pie will probably do, but the following is suggested as being economical and otherwise satisfactory. The dasheens should be boiled and riced as usual.

2 cups of riced dasheen.
¼ cup of butter.
¾ cup of white sugar.
½ teaspoonful of cinnamon.
½ teaspoonful of nutmeg.
1 egg (white and yolk beaten separately).
2 cups of milk.
½ lemon, juice and rind.

Bake in a deep pie tin. Serve warm.

DASHEEN PUDDING.

Proceed the same as with the above recipe for pie. Bake without crust in a deep dish well buttered.

DASHEEN SHOOTS.

1. Cut the blanched shoots into 2-inch lengths, pour on an abundance of boiling water, add salt, and boil for 12 minutes; drain, pour on enough cold[1] milk so that the shoots will be completely covered when it boils, season with salt, and boil for 5 minutes; drain, season with butter, and serve on toast or plain. Cream sauce may be used in serving, if desired.

2. Instead of boiling in milk after draining off the first water, add a little piece of bacon or other fat meat[2] and then cover the shoots with cold water, season with salt, and boil for 5 minutes. Drain and serve.

DASHEEN GREENS.

The young leaves of dasheens and other plants of this class are used for greens, like spinach, in all countries where these crops are grown. The leaves are seemingly in more suitable conditions for greens in the first half of the season than later, and it will probably be found best to restrict their use to the earlier period. They should never be tasted raw.

Remove half or more of the midrib of the leaf and boil for 12 to 15 minutes in water to which a good pinch of baking soda has been added. Drain off the soda water, wash with clear boiling water, and then boil in water seasoned with salt for 20 to 30 minutes, or until tender. Other seasoning may be added as desired.

The above treatment destroys the acridity, but boiling in soda water has been found unnecessary when the greens are cooked with fat meat.

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[1] The purpose in using cold milk or water after the first boiling is to prevent the shoots from becoming too soft.

[2] The fat of the milk or meat seems to assist in destroying the acridity.

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